

Equation d'état de la matière dense: enjeux astrophysiques

Journée IN2P3/GANIL/LPC INDRA-FAZIA



Lami Suleiman



Link between high-energy events/compact objects and dense matter

Accretion
Phenomena

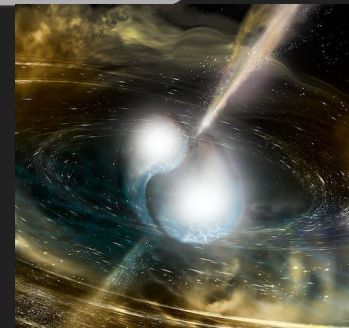
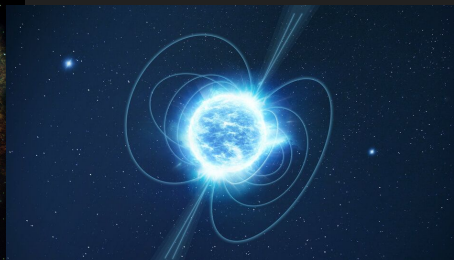
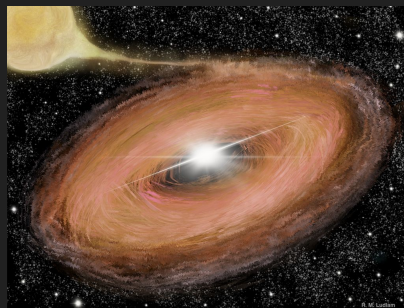
Binary
Systems

Compact object
formation and
evolution

Supernovae,
pulsars,
magnetars

Gravitation
intensive
phenomena

Coalescences



Extreme
thermodynamic
conditions

Dense matter
Properties

Intense
Gravitational
Fields

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Accretion
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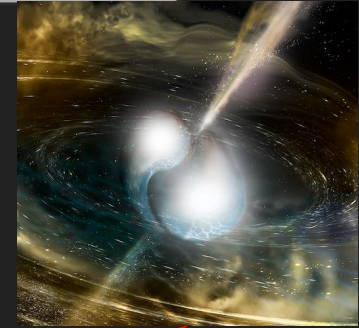
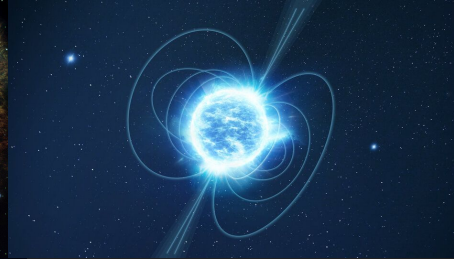
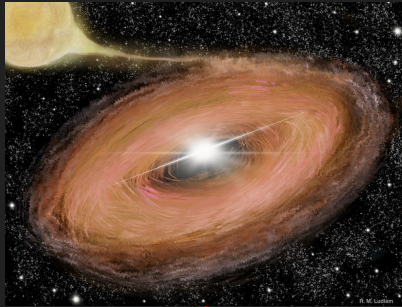
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γ

X

UV

Optical

IR

Radio

ν

Gravitational
Waves

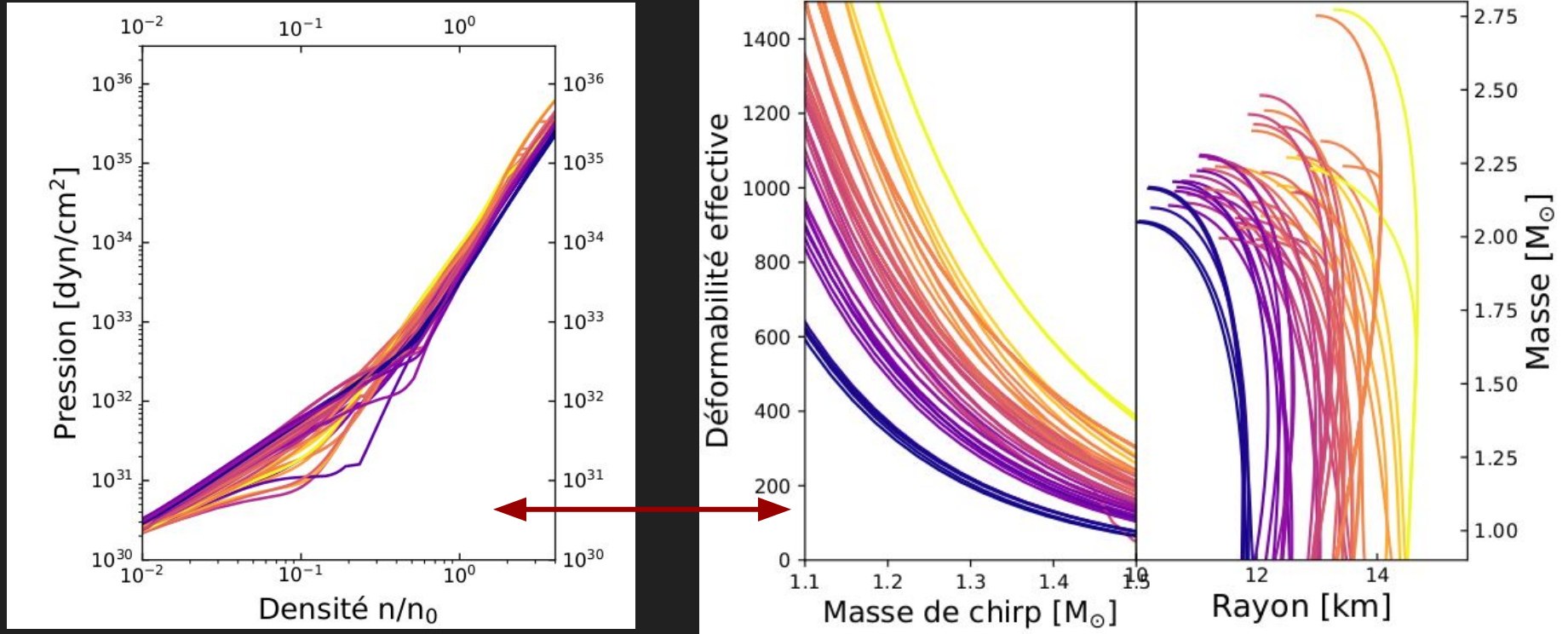
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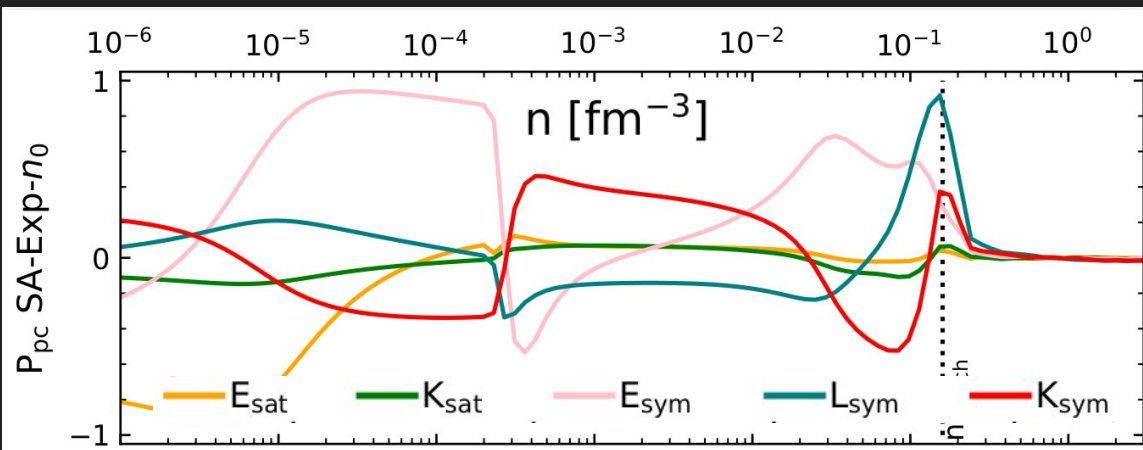
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Dense matter Equation of State (EoS) and Neutron Stars

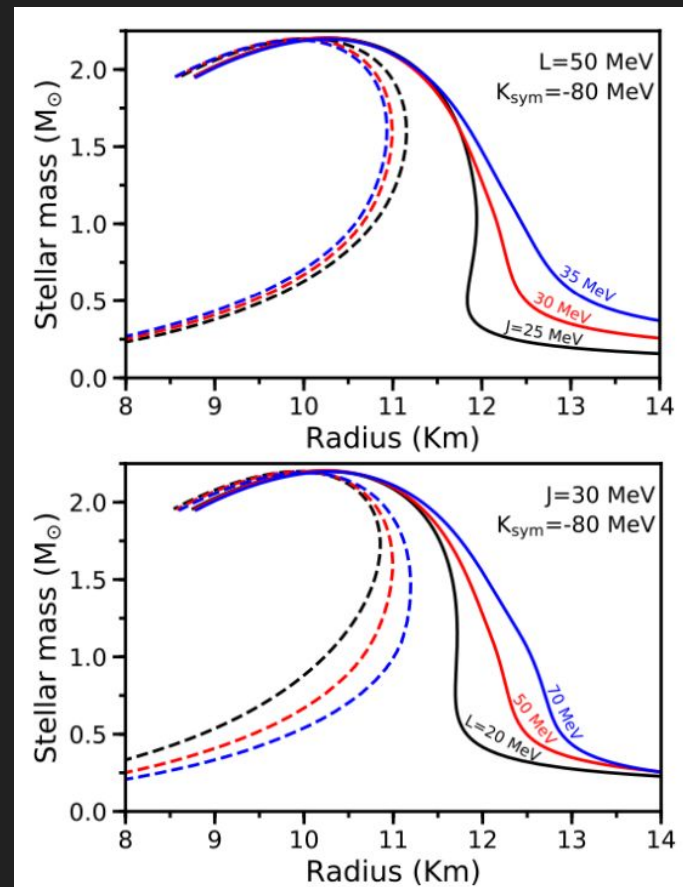
A large number of models could describe matter inside Neutron Stars (NSs)



Impact of symmetry energy on NS parameters



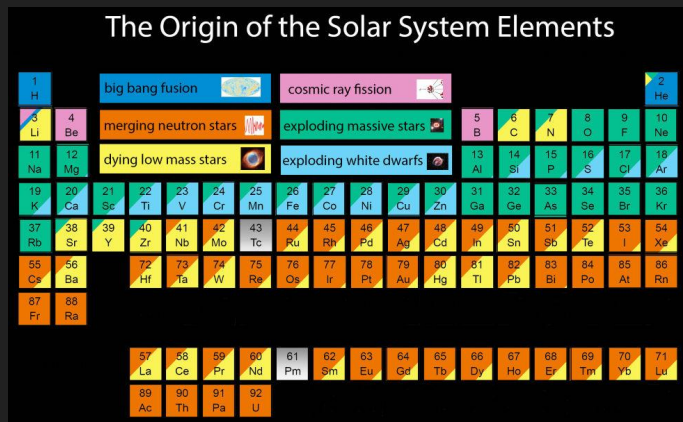
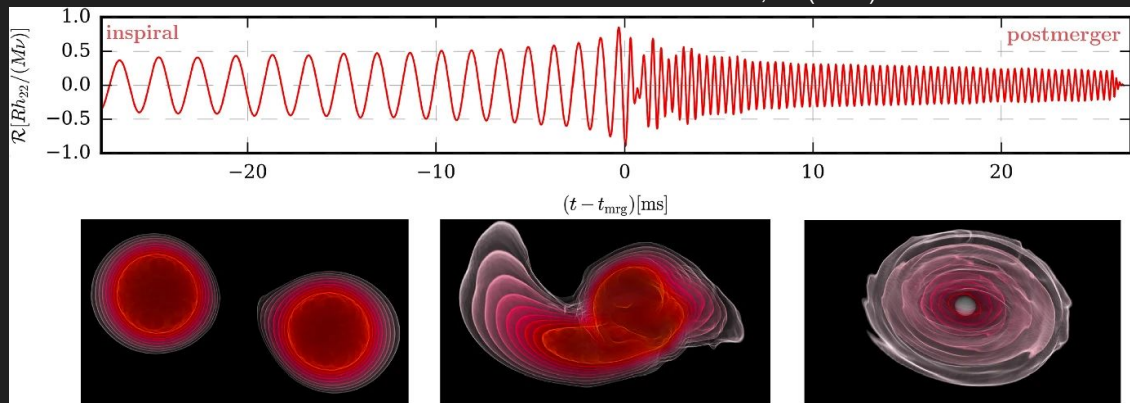
Pearson Correlation factor between nuclear empirical parameters and $P_\beta(n)$ (semi-agnostic constructions *A&A*, 714, A125 (2026)).



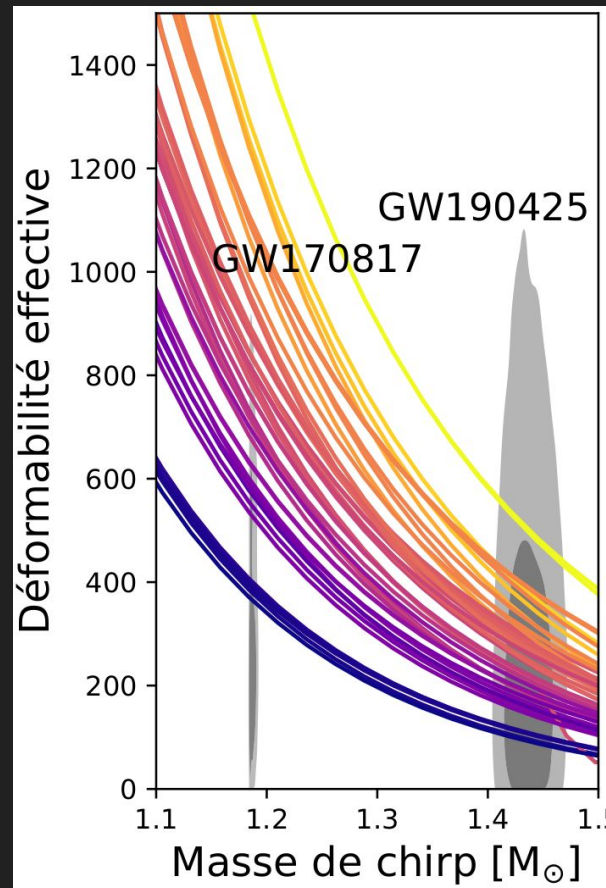
Neil et al. 2015
MNRAS 000, 1–15 (2015)

Dense matter EOS vs Multi-Messenger Astronomy

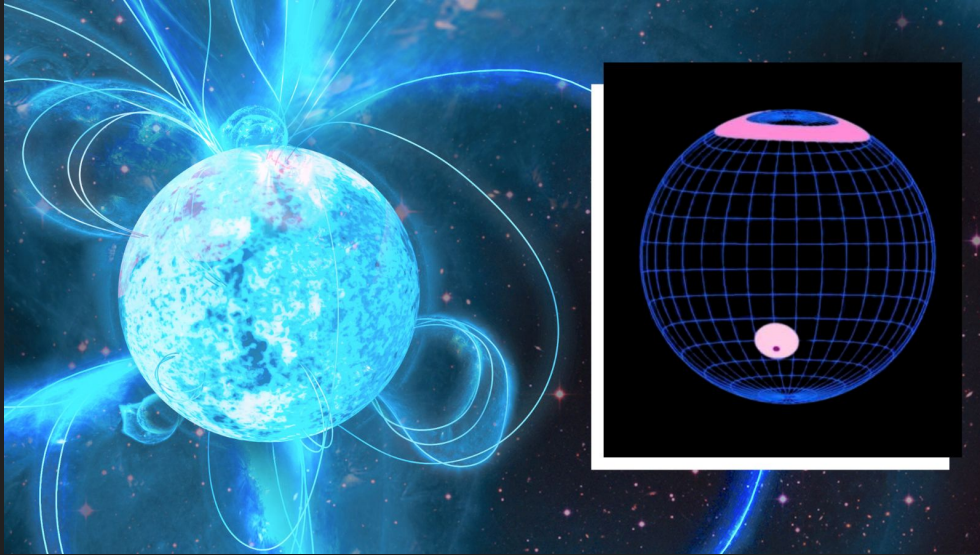
Dietrich et al. 2021 Gen Relativ Gravit 53, 27 (2021)



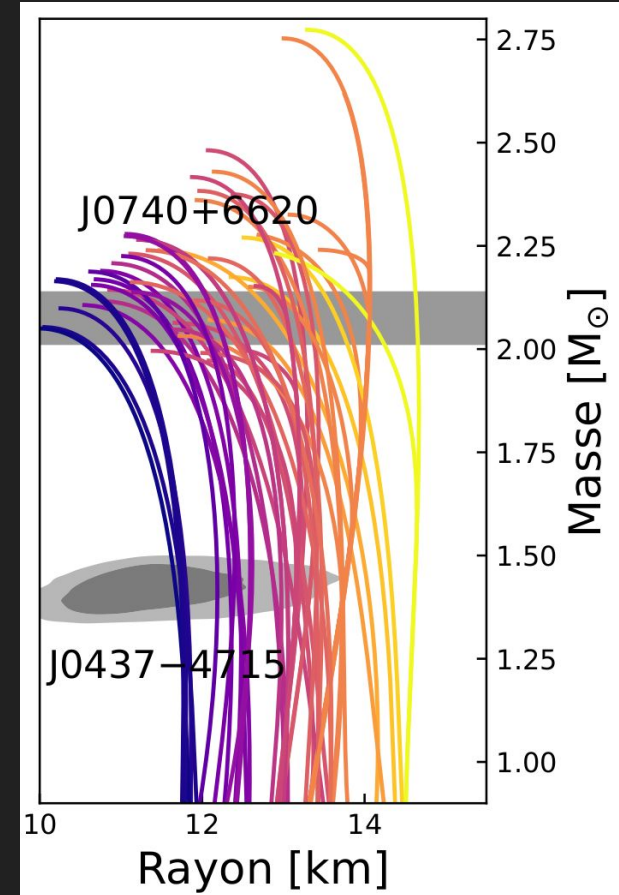
Credits: J. Johnson ESA/NASA/AASNova



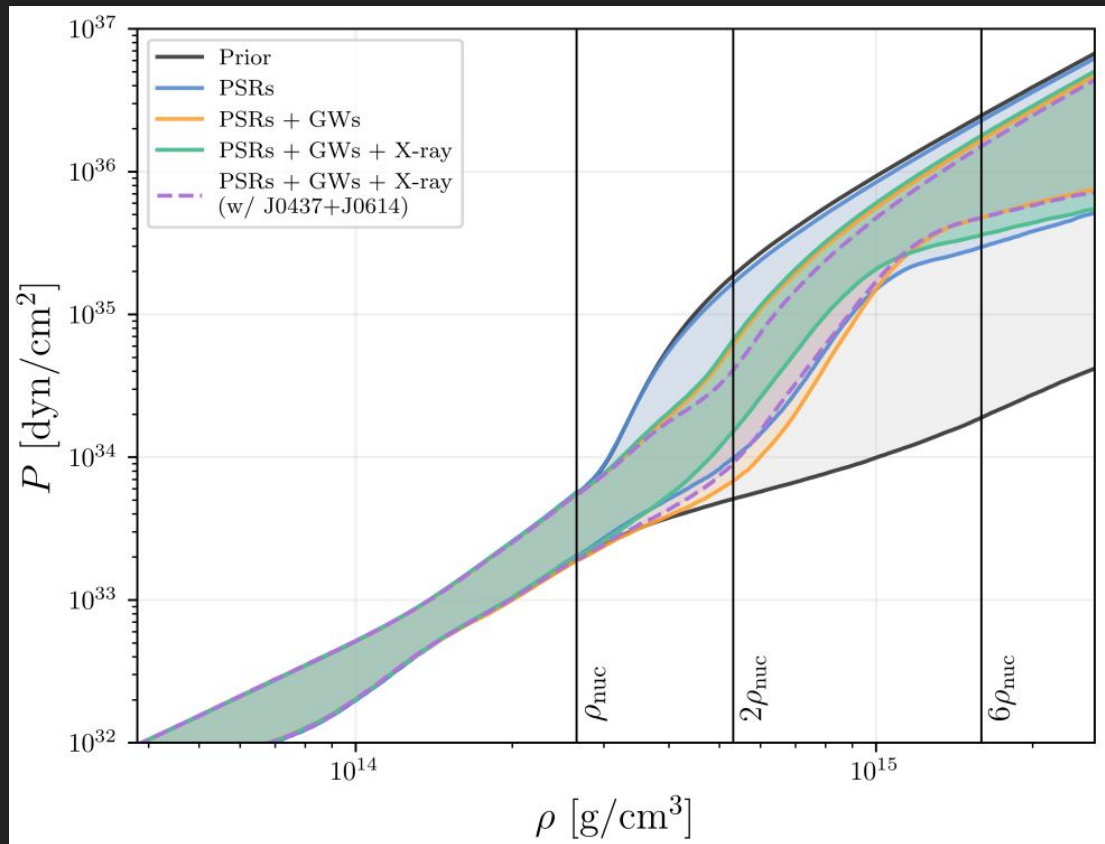
Dense matter EOS vs Multi-Messenger Astronomy



Gendreau et al. 2022

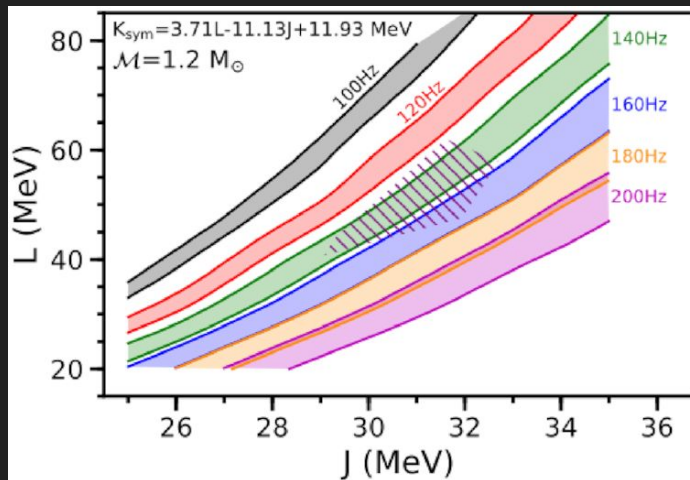
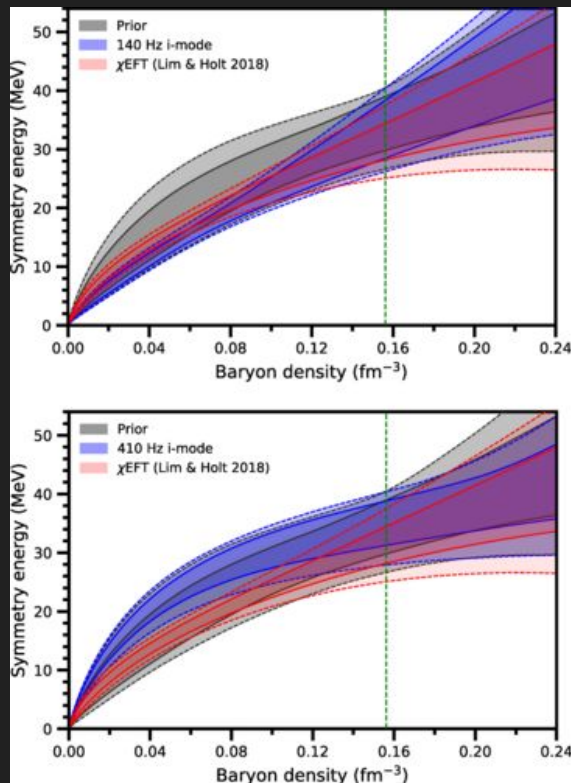


Dense matter EOS vs Multi-Messenger Astronomy

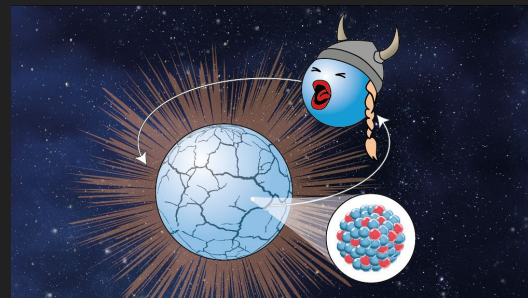


Ng et al. 2025

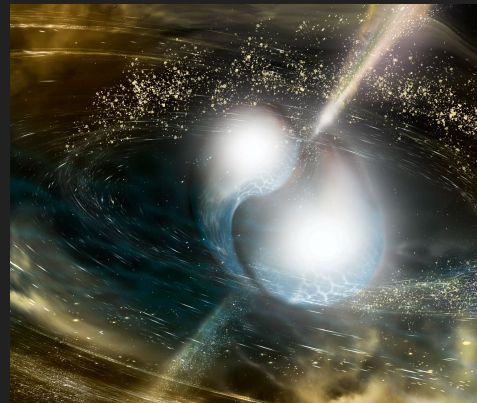
Prospect for confronting nuclear and astrophysical data



Neil et al. 2021

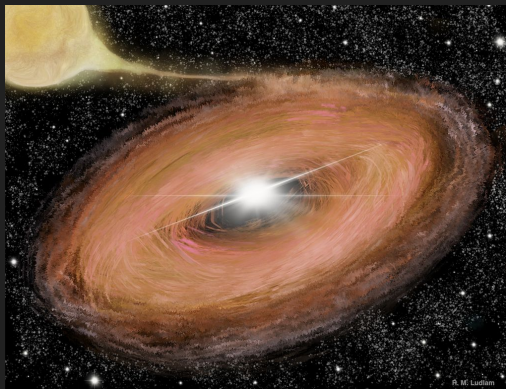


Credits David Tsang

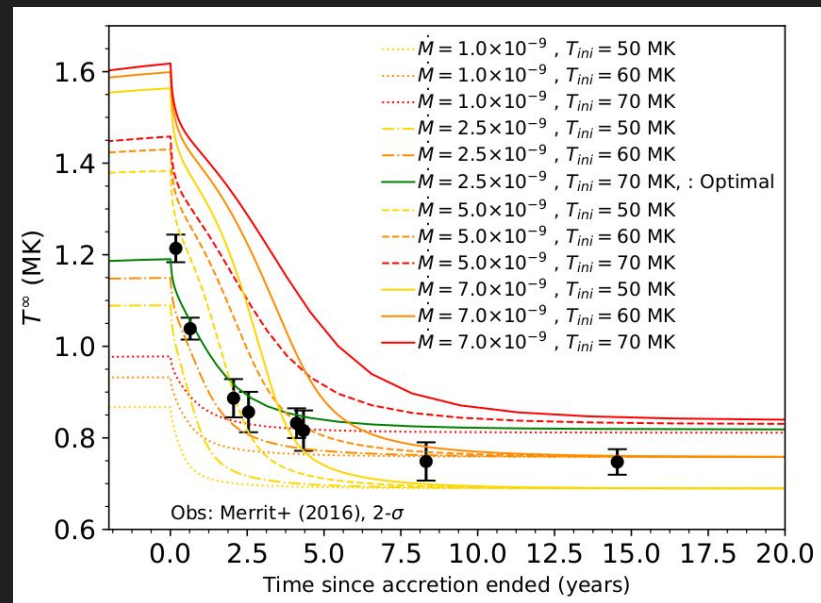
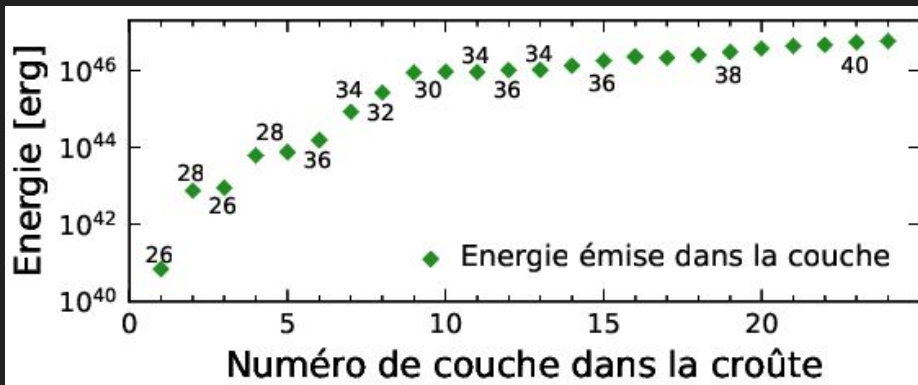


Credits Aurore Simonnet for sonoma state university

Prospect for confronting nuclear and astrophysical data

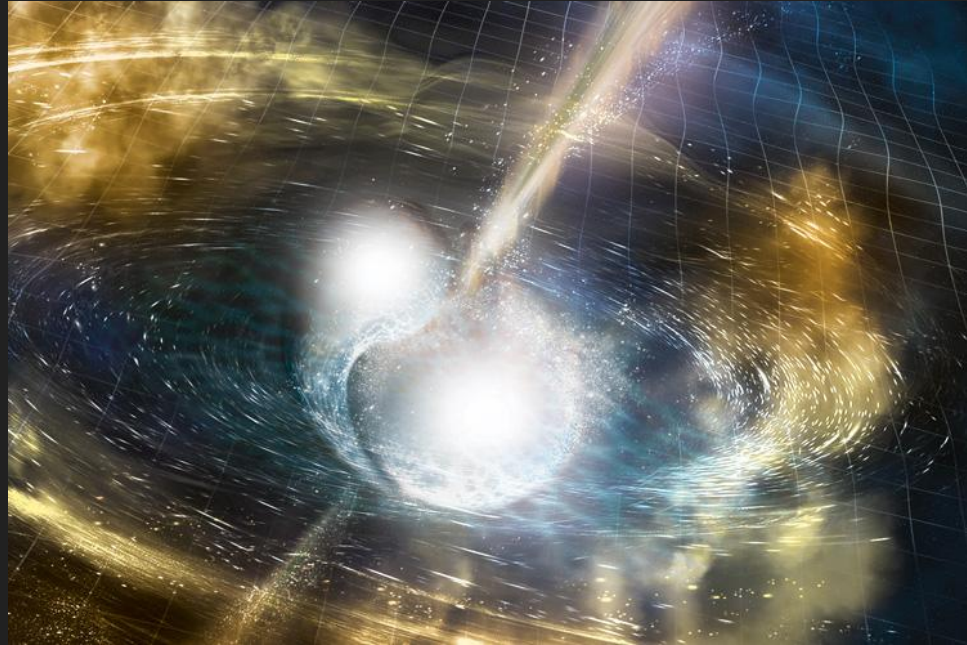


Thermal Evolution of neutron stars



Conclusion

- Dense and neutron rich matter govern a variety of high-energy astrophysical events, and the properties of Neutron Stars.
- Radio, X-ray and Gravitational Waves have already provided constraints on the EoS.
- Next generation of detectors will see further and more accurately, which pushes us for more dense matter information to understand astrophysical mechanisms.



Credits Aurore Simonnet for sonoma state university